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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

SAN FRANCISCO DIVISION

WAYMO LLC, Plaintiff, v. UBER TECHNOLOGIES, INC., OTTOMOTTO LLC; OTTO TRUCKING LLC, Defendants.	Case No. 3:17-cv-00939-WHA **DECLARATION OF PAUL McMANAMON IN SUPPORT OF DEFENDANTS' OPPOSITION TO PLAINTIFF WAYMO LLC'S MOTION FOR PRELIMINARY INJUNCTION** Date: May 3, 2017 Time: 7:30 a.m. Ctrm: 8, 19th Floor Judge: The Honorable William Alsup Trial Date: October 2, 2017

<u>UNREDACTED VERSION OF DOCUMENT SUBMITTED UNDER SEAL</u>

I, Paul McManamon, Ph.D., declare as follows:

1. I have been asked by counsel for Defendants Uber Technologies, Inc. ("Uber"), and Ottomotto LLC ("Otto") and Otto Trucking LLC (collectively, "Defendants") to provide an expert opinion in connection with the technology of LiDAR systems and the allegations in Waymo LLC's ("Waymo")[1] Motion for a Preliminary Injunction ("Motion") and the declaration of Dr. Gregory Kintz in Support of Waymo's Motion ("Kintz Declaration"), specifically the alleged trade secrets identified in Paragraphs 29-35 of the Kintz Declaration and the patent infringement allegations with respect to U.S. Patent Nos. 8,836,922 ("'922 patent") and 9,285,464 ("'464 patent") (collectively, "the Asserted Patents"). I submit this declaration in support of Defendants' Opposition to Waymo's Motion. I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, could and would do so competently.

I. QUALIFICATIONS AND EXPERIENCE

2. I received a Ph.D. degree in physics from the Ohio State University in 1977, and a Master of Science degree in physics from the same university in 1973. I received a Bachelor of Science degree in physics, cum laude, from John Carroll University in 1968.

3. I am currently President of my own company, Exciting Technology LLC, and Technical Director of the Ladar and Optical Communications Institute at the University of Dayton. The term "Ladar" as used in the field of optics has the same meaning as the term "LiDAR" or "lidar," as used in this lawsuit. I currently have four Ph.D. students and one Masters student that I am advising in aspects of LiDAR technology.

4. I worked as a civilian employee of the U.S. Air Force at Wright-Patterson Air Force Base from May 1968 to May 2008. My last job for the Air Force was Chief Scientist for the Air Force Research Laboratory (AFRL) Sensors Directorate, where I was responsible for the technical aspects of all AFRL sensing technologies, including radio frequency (RF) and electro-optical (EO) sensing, automatic object recognition, infrared countermeasures (IRCM), electronic warfare, and device technologies. In this role I was responsible for a technical portfolio covering

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[1] As used in this declaration, the term "Waymo" includes Google.

more than 1,000 scientists and engineers, and more than $500 million of resources. I worked with Dr. Fenner Milton and Dr. Gerry Trunk to found the Military Sensing Symposia, combining IRIS and tri-service radar. Prior to becoming Chief Scientist for AFRL, I was also senior scientist for EO/IR Sensors for the AFRL, and acting chief scientist for the Avionics directorate for more than 2.5 years. In 2006, I received the Meritorious Presidential Rank Award. This award was presented in a ceremony by the Secretary of the Air Force.

5. I chaired the U.S. National Academy of Sciences ("NAS") Study "Laser Radar: Progress and Opportunities in Active Electro-Optical Sensing" (2014). Laser Radar, as used in this NAS study title, is the same as "LiDAR" or "lidar" as used in this lawsuit.

6. I was co-chair of the U.S. NAS study "Optics and Photonics, Essential Technologies for Our Nation" (2012), which recommended a National Photonics Initiative, NPI. This study covered all optical and photonic technology in the United States and the world. It has indirectly resulted in a $610 million center for photonic integrated circuits. I was vice chair of the 2010 U.S. NAS study called "Seeing Photons: Progress and Limits of Visible and Infrared Sensor Arrays."

7. I am a Fellow of the International Society for Optics and Photonics (SPIE), the Institute of Electrical and Electronic Engineers (IEEE), the Optical Society of America (OSA), the AFRL, the Directed Energy Professional society (DEPs), the Military Sensing Symposia (MSS), and the American Institute of Aeronautics and Astronautics (AIAA). I am a former president of SPIE, was on the SPIE board of directors for 7 years, and on the SPIE Executive Committee for 4 years.

8. I am the author of the "Field Guide to Lidar," published by SPIE in 2015. I am also the author of "Review of ladar: a historic, yet emerging, sensor technology with rich phenomenology," published by SPIE's Optical Engineering Journal in 2012.

9. I have taught a graduate course in LiDAR, and multi-day short courses in LiDAR.

10. I received the WRG Baker award from the IEEE in 1998 for the best paper in any refereed IEEE journal or publication (out of over 20,000 refereed papers).

11. A copy of my resume is attached as Exhibit 1 to this declaration.

12. I am being compensated at a standard consulting rate of $200 per hour for my work in connection with this action. I am also being reimbursed for any out-of-pocket expenses. My compensation is not based in any way on the outcome of the litigation or the nature of the opinions that I express.

II. MATERIALS CONSIDERED

13. I have reviewed and considered Waymo's Motion, the Kintz Declaration, the Declaration of Pierre-Yves Droz ("Droz Declaration"), Plaintiff's List of Asserted Trade Secrets Pursuant to Cal. Code Civ. Proc. Section 2019.201 ("Waymo's TS List"), attached as Exhibit 1 to the Declaration of Jordan Jaffe In Support of Waymo's Motion ("Jaffe Declaration"), the Declaration of James Haslim ("Haslim Declaration"), the Declaration of Scott Boehmke ("Boehmke Declaration"), and the Declaration of Michael Lebby ("Lebby Declaration"), the '922 and '464 patents, the '922 and '464 patents' prosecution history, materials identified in Exhibit 2 to this declaration, and references cited in this declaration.

14. I have spoken with two Uber engineers who each led aspects of the development of Uber's Fuji LiDAR. James Haslim led the development of the Fuji LiDAR, and Scott Boehmke led the development of LiDAR requirements, including custom beam patterns and parameters, for a contract with [redacted] and that formed the basis of beam angles in the Fuji. I have reviewed their Declarations. These conversations and declarations indicate that Uber's Fuji system was independently developed by Uber engineers who were not relying on any trade secret information pertaining to Waymo's GBr3 system. Scott Boehmke and his team developed the custom beam patterns and parameters upon which the Fuji system is based, prior to Uber acquiring Otto. Also, the designs of the Fuji and the Gbr3 are **very** different. It is evident from the differences between the Uber and Waymo designs, and from the timing of the development of Uber's custom beam patterns and parameters, that the Fuji LiDAR was independently developed. I have inspected the Fuji system to confirm these differences.

III. LEGAL STANDARDS

15. I have not been asked to offer an opinion on the law and I am not an attorney. However, as an expert assisting the Court in determining whether there was trade secret

misappropriation and patent infringement, I understand that I am obliged to follow applicable law. I set forth below my understanding of the applicable legal principles as explained to me by Defendants' attorneys. I have been asked to apply these legal principles to my analysis.

16. I understand that a trade secret consists of information that derives independent economic value from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use. I understand that information that can be discovered by fair and honest means, such as independent development or reverse engineering, will not receive trade secret protection. I also understand that publicly known information, such as technical information published in patents, books, or articles, or design choices known to engineers in the field, will not receive trade secret protection. I also understand that general skills and knowledge acquired in the course of employment do not constitute trade secrets.

17. I understand that to maintain trade secret protection, a trade secret must be subject to efforts that are reasonable under the circumstances to maintain its secrecy.

18. I understand that trade secret misappropriation means disclosure, or use, of a trade secret without consent by a person who used improper means to acquire knowledge of the trade secret or, at the time of disclosure or use, knew or had reason to know that his or her knowledge of the trade secret derived from, or through, a person who had used improper means to acquire it.

19. I understand that to determine whether there is infringement of a patent: (1) the claims of the patent must be construed; and (2) the properly construed claims must then be compared with the accused products.

20. I understand that Waymo has not proposed any constructions of the claim terms of the Asserted Patents.

21. As the second step in the infringement analysis, I understand that the properly construed claim must be compared to the accused products. I understand that an accused product may infringe a claim either literally or equivalently. I understand from counsel that literal infringement exists when the accused product embodies each and every limitation of a given asserted claim.

22. If a product does not literally embody a particular limitation of the claim, it can

still infringe under the doctrine of equivalents. Determining equivalence involves examining whether the differences between the claimed limitation and the accused product are insubstantial. I understand that one test used to determine equivalence is referred to as the "function, way, result" test. Under this test, to show equivalence, the accused product must perform substantially the same function in substantially the same way to achieve substantially the same result as the claim limitation.

IV. SUMMARY OF OPINIONS

23. Based on my analysis of the alleged trade secrets identified in Paragraphs 29-35 of the Kintz Declaration and my analysis of the '922 and '464 patents, I conclude that: (1) the [redacted] in Paragraphs 29-35 of the Kintz Declaration is not a trade secret; (2) Uber's Fuji LiDAR system was independently developed and the Fuji did not incorporate or rely upon Waymo's [redacted] and (3) Uber's Fuji system does not infringe the '922 and '464 patents.

V. OVERVIEW OF LIDAR AND SELF-DRIVING CARS

24. LiDAR stands for "Light Detection and Ranging." Alternative names for LiDAR in the industry have been "laser radar" or "ladar." Various capitalizations have been used for LiDAR. In this lawsuit it seems the spelling "LiDAR" is being used, with only the "i" in lower case. I usually use the spelling "lidar," with all lower case letters. For this declaration, I will use "LiDAR" to refer to lidar, ladar, laser radar, or opdar, since it is the common term used in this lawsuit.

25. LiDAR is a sensing technique that involves sending light from a laser emitter and measuring the time it takes for the light to reflect off surrounding objects and return to a detector. LiDAR has long been used for applications apart from self-driving cars.

26. An early example of the use of LiDAR was in the late 1960s and early 1970s when "corner-cube reflectors" were placed on the moon by the Apollo 11, 14, and 15 missions. These reflectors use a combination of mirrors that reflect an incoming light beam back in the direction it came from. Scientists on earth bounced laser pulses off these reflectors and calculated the distance between the Earth and the moon to an accuracy of about 3 centimeters. Other early

applications of LiDAR included weather-related uses such as wind sensing and turbulence detection, and military applications such as cruise missile guidance, wire detection, and automatic target identification.

27. LiDAR works in the optical wavelength region, using wavelengths ranging from the visible light region (the human eye sees light with wavelengths from about .45 µm to about .7 µm) to about 11 µm (known as long-wave infrared). By contrast, radar works in the microwave region with wavelengths from millimeters to tens of meters. In comparison to radar, LiDAR has much higher resolution, but has more difficulty seeing through fog and rain. For automotive applications, the most likely wavelengths would be approximately 0.9µm, which is currently most common, or around 1.5 µm, which may become more popular, as components mature, due to eye safety considerations.

28. For illuminating an object, LiDAR systems typically use diode lasers or diode pumped solid state lasers. Diode lasers have limited peak power. Because of this limited power, many LiDAR systems using diode lasers will match one laser diode per detector, whereas LiDAR systems using diode pumped solid state lasers would use one laser to illuminate an area viewed by many detectors.

29. Automotive applications for LiDAR typically use a short range 3D form of LiDAR. In such applications, LiDAR has the advantage over passive sensors of providing range measurements at each angular location. Using 3D LiDAR, a 3-dimensional image, or point cloud, can be formed, providing locations of objects around the vehicle in angle/angle/range space. This allows the driverless car to know the range to any object location in azimuth and elevation viewed by the LiDAR.

30. Automotive applications of LiDAR date back to at least the 1980s, when the Defense Advanced Research Projects Agency (DARPA) funded the Autonomous Land Vehicle (ALV) project in cooperation with academic institutions such as Carnegie Mellon University (CMU). DARPA conducted a 1985 road demonstration with an autonomous vehicle using a color video camera and laser range scanner, which a 1986 report on the ALV project identified as a laser range finder built by ERIM. CMU worked with DARPA to develop an autonomous vehicle

called the NavLab that also used the ERIM laser range finder.

31. By the mid-90s, manufacturers were experimenting with using LiDAR for automotive collision avoidance systems. For example, U.S. Patent No. 7,209,221, which claims priority to a 1993 German patent, discloses a blindspot detection system using laser diodes installed on the car mirrors. This patent identifies advantages of using LiDAR: "Laser Radar: As with regular radar, two techniques exist: (1) a pulsed-beam of infrared light coupled with time-of-flight measurements, and (2) the modulation of a continuous light beam. The pulsed technique offers long range, high directionality, and fast response time. Its limitations are its sensitivity to environmental conditions." ('221 patent at 4:33-38.) Today, cars from manufacturers like Volvo and Infiniti are equipped with LiDAR-based advanced driver assistance systems (ADAS).

32. In 2004, DARPA funded the first Grand Challenge, the world's first long distance competition for self-driving cars. The Grand Challenge was held again in subsequent years. The autonomous vehicles in the 2004 and 2005 Grand Challenges used LiDAR systems from sensor companies, such as the German company SICK AG. One of the entrants in the 2005 Grand Challenge was David Hall and his company Velodyne Acoustics Inc., now Velodyne LIDAR Inc. ("Velodyne"). Velodyne created a LiDAR sensor that used multiple diode lasers and detectors, with a rotary motor to rotate the housing about a base. The winner of the 2007 Grand Challenge used Velodyne's HDL-64E sensor, a 64-laser LiDAR system. Velodyne's LiDARs are some of the most popular systems in the self-driving car industry and have been used by both Waymo and Uber for their self-driving cars.

VI. UBER'S INDEPENDENT DEVELOPMENT OF LIDAR SYSTEM

A. Overview and Comparison of Uber and Waymo LiDAR Systems

33. As described below, the Fuji LiDAR is based on requirements, including custom beam patterns and parameters, developed at Uber by Mr. Boehmke before the acquisition of Otto, without reliance on any Waymo trade secret information. To illustrate the relevant differences between Waymo's GBr3 system and Uber's Fuji system, the following chart provides a summary comparison of key features. I discuss these features in more detail below.

Comparison of Systems	
GBr3 LiDAR	Fuji LiDAR
[redacted] ***Single lens aperture***: Shared lens for transmitted and received light.	[redacted] ***Four lens apertures***: Separate lenses for each of 2 transmit paths and 2 receive paths.
[redacted] ***Single cavity***: Overlapping transmit and receive paths in single cavity.	[redacted] ***Two cavities***: Separate medium range and long range cavities. Each cavity has separate transmit and receive paths.

Comparison of Systems	
GBr3 LiDAR	Fuji LiDAR
[redacted]	[redacted] *transmit blocks*: Each cavity has a separate [redacted] transmit block with 32 diodes.

34. In the LiDAR field, the term "monostatic" is used to refer to LiDARs that have only one aperture through which both the outgoing light (transmit) and incoming light (receive) will pass. By contrast, a "bistatic" LiDAR is a system with separate apertures for the transmitted and received light. (*See* Paul McManamon, *Field Guide to Lidar* 12 (2015) (describing monostatic and bistatic systems).)

35. Waymo's GBr3 LiDAR is a monostatic system, meaning that it has a single exterior aperture through which transmitted and received light will pass. As shown in the illustration below (taken from Kintz Declaration, with labels and shading added), the GBr3 has a shared lens fitted in the exterior aperture that is used both to collimate the outbound transmitted light and collect the inbound received light. The GBr3 is comprised of a single optical cavity in which the transmit path (shown in red below) and receive path (shown in blue) will overlap.

[redacted]

36. By contrast, Uber's Fuji LiDAR is a combination of two bistatic systems, each of which is housed in a separate cavity. As shown in the annotated CAD drawing below of a cross-sectional top view of the LiDAR (Haslim Declaration ¶ 13), the Fuji comprises a medium-range cavity and a long-range cavity. Each cavity has separate transmit and receive paths divided by non-reflective metal walls, with separate lenses for each path. In total, the Fuji has four exterior apertures fitted with four separate lenses. The transmit and receive light paths do not overlap in the Fuji system, because each path is physically separated from the others. The long-range cavity is positioned level with the ground, while the medium-range cavity is tilted downwards by 12 degrees from level. When the two cavities are mounted next to each other, there is a substantial metal wall between them. The two cavities in the Fuji system are really two LiDARs packaged in a single rotating housing.

[redacted]

37. With respect to the transmit blocks of these systems: The GBr3 utilizes a [redacted], with [redacted] incorporating a total of 64 laser diodes. I understand that [redacted], with the [redacted] situated on the [redacted] resulting in the following pattern: [redacted].

38. In the Fuji system, each cavity has a separate [redacted] transmit block containing 32 diodes. The [redacted] transmit blocks are physically separate from each other. Given the 12 degree tilt of the medium-range cavity, the [redacted] transmit block for that cavity is also tilted 12 degrees from level, and thus is 12 degrees out of alignment with the [redacted] transmit block for the long-range cavity. As shown in the drawing above, the distribution of laser diodes on the PCBs across the two [redacted] blocks from left to right [redacted] has the following pattern: [redacted]

39. Waymo has indicated that the GBr3 LiDAR has a vertical field of view of [redacted]

40. The Fuji design combines two LiDARs: a medium-range LiDAR in one cavity and

a long-range LiDAR in a different cavity. The vertical field of view of the medium-range LiDAR is -22.0 degrees to -4.22 degrees (for a total field of view of 17.78 degrees). The vertical field of view of the long-range LiDAR is -3.92 degrees to 8.23 degrees (for a total field of view of 12.15 degrees).

B. Development of Uber's Fuji LiDAR

41. In his Declaration and discussion with me, Mr. Boehmke explained the genesis of the dual 32-channel LiDAR design, varied vertical field of view, curved transmit PCBs, and separate transmit and receive lenses of the Fuji system.

42. As documented in an October 15, 2015 version of his LADAR Design Notebook, Mr. Boehmke recognized by that time that [redacted] were heavily dependent on the speed of a vehicle. (Boehmke Decl. ¶ 6.) He considered adjusting the [redacted] based on this speed, noting consideration of a [redacted] (*Id.*) The October 15, 2015 entry in his design notebook also recorded consideration of a third-party LiDAR from [redacted] which used [redacted] (Boehmke Decl. ¶ 7.)

43. From November 2015 to March 2016, Mr. Boehmke worked on developing custom beam patterns and parameters for Uber's self-driving cars based on the technical restraints of [redacted] LiDAR sensors and the design standards for American roads. (Boehmke Decl. ¶ 8.) An [redacted], showed [redacted] being developed by Uber. (Boehmke Decl. Ex. D):

[redacted]

44. In March 2016, Uber entered into a contract with [redacted] to develop dual 32-channel LiDAR sensors that would work together to achieve 64-channel resolution with Uber's custom beam patterns and parameters. (Boehmke Decl. ¶ 8.) As shown in Uber's [redacted] and in the preliminary and final specifications that Uber provided to [redacted], these custom beam patterns would create a [redacted] (*Id.*)

45. As shown in the December 7, 2015 version of his LADAR Design Notebook, Mr. Boehmke also worked on LiDAR designs that positioned laser diodes around the curved edge of a transmit PCB, and that used [redacted] and separate transmit and receive lenses. (Boehmke Decl. ¶ 10.) In a February 17, 2016 version of his LiDAR design analysis, Mr. Boehmke also explored [redacted]. (Boehmke Decl. ¶ 11.) In contrast, [redacted] LiDAR sensors used [redacted] Mr. Boehmke's design included [redacted]. (*Id.*)

46. The design choices and requirements described above were examined and developed by Mr. Boehmke prior to Uber's acquisition of Otto in August 2016. (Boehmke Decl. ¶ 13.)

47. In his Declaration and discussion with me, Mr. Boehmke explained that by late October 2016, he and Mr. Haslim decided that Mr. Haslim's team should switch from developing Otto's preexisting LiDAR to developing the Fuji design based on Mr. Boehmke's work from before the Otto acquisition. (Boehmke Decl. ¶ 14.)

48. Mr. Boehmke pulled together the design options he previously considered and developed those into the dual 32-channel LiDAR design that became Uber's Fuji system. (Boehmke Decl. ¶¶ 14, 16.) In a November 4, 2016 document, Mr. Beohmke provided a summary of the custom beam spacing and angles he had developed. (Boehmke Decl. ¶ 16.) The positioning and orientation of the diodes on the transmit board of the Fuji design are based on Mr. Boehmke's work on custom beam spacing and angles. (*Id.*)

VII. WAYMO'S TRADE SECRET ALLEGATIONS

49. I understand from the Kintz Declaration that Mr. Kintz has opined that Defendants' Fuji LiDAR devices incorporate a number of Waymo trade secrets. Below, I respond to Mr. Kintz with respect to Waymo's alleged trade secrets specifically identified in Paragraphs 29-35 of his Declaration. To the extent Mr. Kintz supplements his opinions or addresses additional alleged trade secrets, or other information becomes available, I reserve the right to respond.

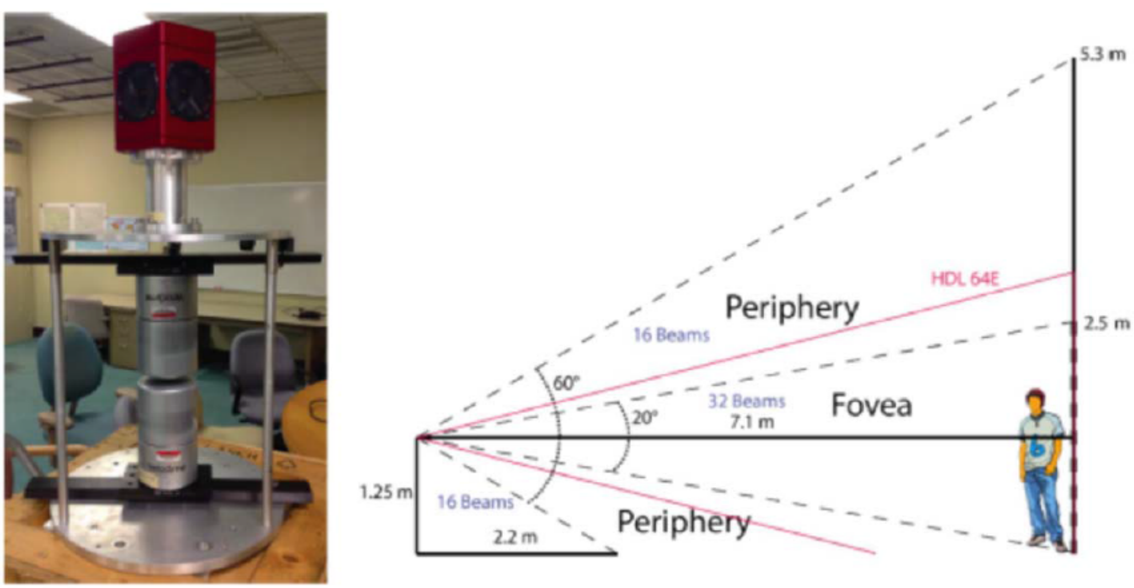
A. [redacted] (TS List Nos. 1, 4, 6, 28-30, 39, 94-99)

50. In Paragraphs 29-43 of his Declaration, Mr. Kintz opined that [redacted] such that there is a [redacted] is a Waymo trade secret. According to Mr. Kintz, the laser diodes in Waymo's previous generation GBr2 design were generally [redacted] whereas the [redacted] in Waymo's current generation GBr3 [redacted] In particular, Mr. Kintz opines that he is unaware of any public disclosure of this type of [redacted] design. He states that this

concept is not disclosed in the '922 patent or in the Velodyne HDL-64E, which purportedly both [redacted]

51. The concept of [redacted] is not a trade secret. [redacted] is a well-known optical concept called foveated vision. The human eye uses foveated vision: when you look in a given direction you have higher resolution in the central region of your field of view, and lower resolution in the peripheral areas. Many papers have been published using this concept to increase resolution in the central region of an optical sensor.

52. [redacted] is an obvious extension of current optical systems practice. For example, in early 2015, a research group at HRL Laboratories in Malibu, California, published a design that mounted two Velodyne 32E LiDARs on top of each other to achieve [redacted]. (*See* Mundhenk, et al., "PanDAR: A wide-area, frame-rate, and full color LIDAR with foveated region using backfilling interpolation upsampling." (attached as Exhibit 4).) Figure 1 from the PanDAR paper illustrates this concept:



53. The concept of a curved transmit PCB is certainly not a trade secret, as it is disclosed in public references. Waymo's own '922 patent discloses the use of "light sources

[that] can be mounted on a curved edge of one or more vertically-oriented printed circuit boards (PCBs), such that the curved edge of the PCB substantially matches the curvature of the focal surface in the vertical plane of the PCB." ('922 patent, at 5:14-19.) As shown in Figure 4 of the '922 patent, below, the transmit PCB contains "a plurality of light sources 422 a-c (e.g., laser diodes) that are placed around the edge of the PCB with spacing between the diodes."

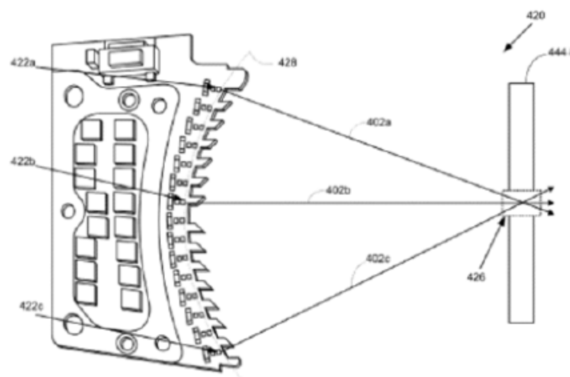


FIG. 4

54. The concept of [redacted] is not a trade secret, as it is expressly stated in Velodyne's U.S. Patent No. 8,767,190 (attached as Exhibit 3), which claims priority to a provisional application filed in 2006. The '190 patent discloses a Velodyne LiDAR system with 32 laser diodes, each on a separate PCB. ('190 patent, Fig. 8 at item 30.) The laser PCBs are arranged in a curved stack (item 30) within the system. (*Id.*) On the opposite side is a corresponding stack of PCBs (item 32) with detectors for sensing the incoming light. (*Id.* at item 32.)

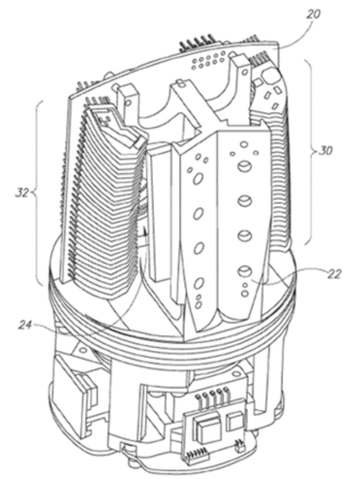


FIG.8

55. Figure 5 of the '190 patent shows a side view of the detector stack, which is identical in arrangement to the laser stack. I have annotated Figure 5 below to illustrate how the laser diodes would be positioned in the disclosed system (recognizing that the lasers would be on the opposite side of the one depicted in Figure 5). As shown in the figure below, the diodes are located on the rear edge (right side) of each PCB facing backwards towards the mirror 40. Laser light from the diodes will reflect off mirror 40 and pass through lens 50. ('190 patent, Col. 5:49-51.) As can be seen, the diodes are arranged in a curved pattern ("fan pattern") organized around a central axis. (*Id.* at Col. 56-67.) The angles of the laser diodes can be adjusted based on the "desired range of the system." (*Id.*)

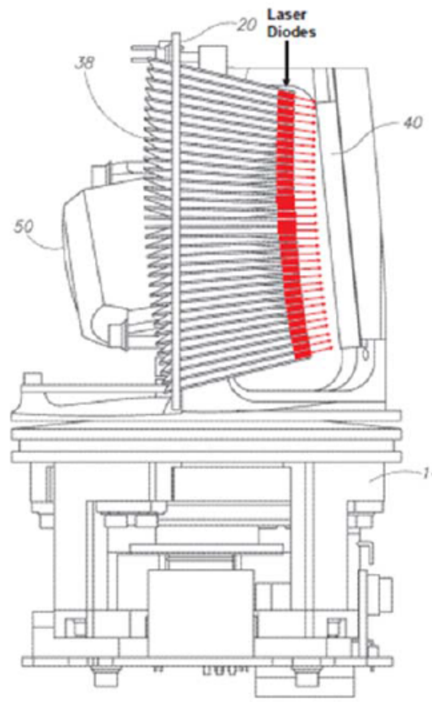


FIG. 5

56. The '190 patent discloses that the [redacted]. The patent states: "The density of emitter/detector pairs populated along the vertical FOV is ***intentionally variable***. While 32 pairs of emitters and detectors are shown in the illustrated versions, the use of hybrids and a motherboard allows for a reduction in the number of emitters and detectors by simply removing or not installing any desired number of emitter/detector pairs." ('190 patent at Col. 6:45-50.) The patent further explains: "For some uses increased density is desirable to facilitate seeing objects at further distances and with more vertical resolution." (*Id*. at Col. 6:54-56.)

57. This disclosure teaches that by removing or not installing some of the laser PCBs in the fan pattern, [redacted] can be achieved. As noted in the patent, [redacted] in Waymo's GBr3 [redacted]. I have annotated Figure 5 below to show an example of [redacted] achievable in the system of the '190 patent.

[redacted]

58. The '190 patent also discloses at Col. 6:61-7:7 that multiple laser diodes can be mounted together on one PCB at different vertical angles to achieve an [redacted] and improve resolution:

> [M]ultiple emitters and detectors can be designed and mounted onto the hybrid boards at slightly different vertical angles, thus increasing the density of vertical FOV coverage in the same footprint. If, for example, two emitters and two detectors were mounted on each of the hybrids shown in FIGS. 6 and 7 with slight vertical offsets, the design would incorporate 64 emitters and detectors rather than 32. This example design describes two emitters and detectors mounted per board, but there is no practical limit to the number of emitters and detectors that may be mounted on a single board. The increased number of emitters and detectors may be used to increase the field of view by adjusting the relative orientation, or may be used to increase the density of points obtained within the same field of view.

59. For the reasons stated above, the concept of [redacted] was known in the optical field, and specifically in the LiDAR field, and is not a Waymo trade secret.

60. Furthermore, my discussions with Fuji designers Mr. Haslim and Mr. Boemke,

along with my review of their declarations, indicate that the Fuji system was based on the development of custom beam spacing and angles at Uber prior to the acquisition of Otto. As discussed above, Waymo's alleged trade secrets regarding [redacted] were not trade secrets, but were information known to a reasonably skilled practitioner designing LiDARs, like Mr. Boehmke. I also note that the spacing of laser diodes on the Fuji transmit PCBs is different between the medium-range and long-range cavities. (*See* Haslim Decl. ¶ 15-16.) The laser diodes on the transmit PCBs in the long-range cavity have [redacted]. (*Id.*)

B. Comments on Other Alleged Waymo Trade Secrets

61. I have reviewed Waymo's TS List (Exhibit 1 to the Jaffe Declaration). Waymo's Motion and the Kintz Declaration purport to address only certain alleged trade secrets from Waymo's TS List, including TS List Nos. 1, 2-4, 6-7, 14, 28-30, 39, and 94-99. I reserve the right to submit a supplemental declaration addressing any other alleged trade secrets from the TS List that Waymo raises in its further briefing or declarations.

62. As described below, many of the alleged trade secrets on Waymo's TS List are quite broad in scope and cover features that would exist in almost any rotating LiDAR system for automotive use. If these broad features were deemed to be Waymo's trade secrets and Defendants were enjoined from using them in their LiDAR designs, it may have the effect of precluding Uber from developing any rotating LiDAR system for automotive use.

63. TS List No. 19 claims as a trade secret [redacted] The use of [redacted] is commonplace, as is the use of [redacted] If such a feature were deemed a Waymo trade secret, it may greatly limit Uber's ability to develop an effective rotating LiDAR system for automotive use.

64. TS List No. 27 claims as a trade secret the [redacted] In my experience, LiDAR systems are generally designed to achieve [redacted] [redacted] is usually chosen to

meet a detection or identification goal, which has to do with the [redacted] If such an idea were deemed a Waymo trade secret, it may greatly limit Uber's ability to develop an effective LiDAR system for automotive use.

65. TS List No. 38 claims as a trade secret a 64 beam LiDAR system configured to provide a vertical field of view of [redacted]. This vertical of field of view is approximately what a person of ordinary skill would expect in any automotive LiDAR system operating on relatively flat terrain, given the mounting of LiDARs on top of a vehicle and the general need to see objects in front of and around a vehicle but not above it. If such a vertical field of view were deemed a Waymo trade secret, it may greatly limit Uber's ability to develop an effective LiDAR system for automotive use. (As I note above, the Fuji system uses two cavities that do not have the same vertical field of view as the GBr3. But to the extent Waymo claims that their vertical field of view is a trade secret, it will hinder the general development of LiDAR.)

66. TS List No. 44 claims as a trade secret a 64 beam LiDAR system having a [redacted] ranging from [redacted] In any LiDAR system, the [redacted] is generally set so as not to exceed the unambiguous range of the system. The unambiguous range of a LiDAR is the maximum range you can image without having multiple pulses in the air at the same time. Unambiguous range is calculated by the following formula, where c is the speed of light and τ is the time between pulses:

$$R_{\text{unambig}} = \frac{c\tau}{2}$$

(McManamon, *Field Guide to Lidar* 91.) The table below shows the unambiguous range for [redacted]. Given that it is not desirable to operate beyond the unambiguous range (i.e., you want each pulse to complete its trip and be received by the sensor before the next pulse is sent), the [redacted] at which the LiDAR is operating. If this concept were deemed a Waymo trade secret, it

may greatly limit Uber's ability to develop an effective LiDAR system for automotive use.

[redacted]

67. TS List No. 45 claims as a trade secret a LiDAR system having [redacted] ranging from the [redacted] It is well-known in the field of LiDAR that [redacted] to achieve uniform resolution as measured in size of the object being viewed, when viewing objects at different ranges. [redacted] will generally be needed to maintain spatial resolution for objects at greater distances, because the light spreads out when traveling to the object and being reflected from the object. (*See* Paul McManamon, *Field Guide to Lidar* 14 (2015) (LiDAR range equation).) If this concept were deemed a Waymo trade secret, it may greatly limit Uber's ability to develop an effective LiDAR system for automotive use.

68. TS List No. 62 claims as a trade secret [redacted] LiDAR system with a [redacted] It is well-known in the field of LiDAR that it is beneficial [redacted] if possible, to reduce noise. It is standard practice in LiDARs to configure the receiver to [redacted] If this concept were deemed a Waymo trade secret, it may greatly limit Uber's ability to develop an effective LiDAR system for automotive use.

VIII. THE '922 PATENT

A. Overview of the '922 Patent

69. The '922 patent discloses a LiDAR system using a single lens for collimating the transmission beams and for focusing the reflected light beams onto the detectors via the receive path. This is a monostatic LiDAR system. (*See* Paul McManamon, *Field Guide to Lidar* 12

(2015).) The embodiment of the '922 patent is illustrated in Figure 2 (reproduced below):

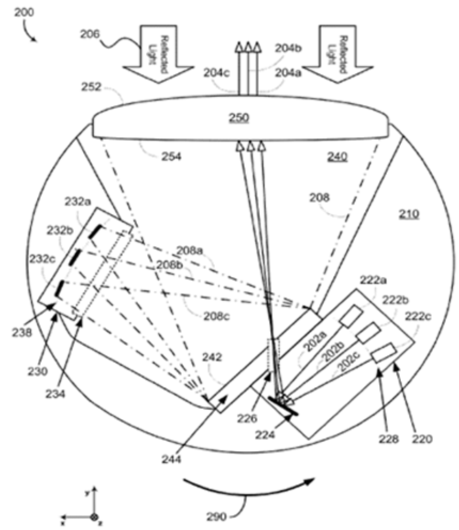


FIG. 2

70. As shown in Figure 2, a transmit block **220** includes light sources that emit a plurality of light beams along a transmission path (**202a-c**) that are reflected by a mirror **224** and pass through an exit aperture **226**. The transmission beams pass through lens **250**, which collimates the light beams for transmission into the surrounding environment to reflect off objects. ('922 patent at 11:62-12:43.)

71. The reflected beams return to the system and are focused by lens **250** to bounce off of reflective material on wall **244** and travel through entrance aperture **234** to the detectors **232a-c**. ('922 patent at 12:44-49, 13:1-10.)

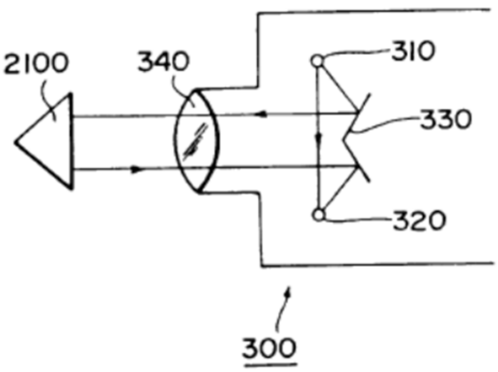
72. All claims of the '922 patent require a single "interior space" containing both the transmit and receive paths, a "reflective surface" in the receive path, and a single lens for transmitting and receiving light. For example, Claim 1 recites (emphasis added):

> 1. A light detection and ranging (LIDAR) device, comprising:
>
> a lens mounted to a housing, wherein the housing is configured to rotate about an axis and has **an interior space that includes a transmit block, a receive block, a transmit path, and a receive path,** wherein the transmit block has an exit aperture in a wall that comprises **a reflective surface**, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, and wherein **the receive path extends from the lens to the entrance aperture via the reflective surface**;

> a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range;
>
> a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and
>
> wherein **the lens is configured to** receive the light beams via the transmit path, **collimate the light beams for transmission** into an environment of the LIDAR device**,** collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device, **and focus the collected light onto the detectors via the receive path.**

73. In Paragraph 56 of his Declaration, Mr. Kintz opines that the "key innovation over prior art" in the '922 patent is the use of a common lens for the transmit and receive paths. However, during the prosecution of the application that led to the issuance of the '922 patent, the Examiner initially rejected the independent claims as obvious over a combination of U.S. Patent No. 7,969,558 (Hall), U.S. Patent No. 6,046,800 (Ohtomo), and U.S. Application No. 2002/014924 (Wangler), that disclosed the concept of using a common lens for transmitted and received light. In particular, the Examiner found that Ohtomo teaches an optical wave range finder using a laser and a "multi-functional lens." (February 13, 2014 Non-Final Rejection at 5.) As illustrated in Figure 14 (below), the embodiment of Ohtomo uses "an object lens 340 for **collimating** the range measuring light to cause the light to be **focused on the receiving part 320**." (Ohtomo at 3:55-57 (emphasis added).) As shown in Figure 14, object lens 340 both collimates the outbound beams and focuses the inbound beams:

F I G . 1 4



74. Mr. Kintz's Declaration does not mention Ohtomo's disclosure of a common lens, nor does it describe the applicant's response to the initial rejection for obviousness in view of Ohtomo, distinguishing Ohtomo on the basis that it lacked "an exit aperture in a wall that comprises a reflective surface." Mr. Kintz's Declaration also does not mention the known use of monostatic LiDAR systems for the last several decades.

B. Person of Ordinary Skill in the Art

75. In Paragraph 19 of the Declaration, Mr. Kintz opines that "a person of ordinary skill in the art at the time of the invention would have had a Bachelor of Science degree in Physics, and at least three years' experience in laser-based optical mapping systems, or the equivalent." In my opinion, a person of ordinary skill in the art would have a Master's degree in Physics, Electrical Engineering, Electro-Optics, or related fields and at least three years of experience in the optical field, preferably in LiDAR; or have a Bachelor's Degree in Physics, Electrical Engineering, Electro-Optics, or related fields and at least five years of experience. I understand that the definition of a person of ordinary skill takes into consideration factors such as the education and experience of inventors, and I reserve the right to amend my opinion on the definition of a person of ordinary if more information becomes available with respect to the inventors of the '922 and '464 patent.

C. Non-infringement of Claims 1 and 13

76. Uber's Fuji design does not infringe Claim 1 of the '922 patent because it does not contain (1) "an interior space that includes . . . a transmit path, and a receive path"; (2) a

"reflective surface" through which the receive path extends to the receive board; or (3) a single lens configured to both "collimate the light beams for transmission" and "focus the collected light onto the detectors via the receive path."

77. Claim 13 of the '922 patent depends from Claim 1, and Uber's Fuji design does not infringe Claim 13 because it does not infringe Claim 1.

i. Uber's Fuji Design

78. Uber's Fuji design has two separate LiDAR cavities, each with separate compartments for the transmit and receive path, as well as separate lenses for collimating outbound light and for focusing inbound light. The CAD drawing below illustrates the pertinent components of the Fuji design from a cross-sectional top view:

[redacted]

79. As shown in this diagram, the Fuji design has two cavities – a medium-range cavity and a long-range cavity. Each individual cavity contains one compartment for the transmit path (marked with red), where light is emitted from diodes on the [redacted] transmit block (labeled [redacted] and travels to the transmit lens. Each individual cavity also contains one

compartment for the receive path (marked with blue), where light is collected and focused by the receive lens to the receive board (labeled "Receive PCB"). The transmit path and the receive path do not share the same compartment because they are divided by a non-reflective metal separation (like a wall), nor do they share the same lenses.

80. Below are annotated photographs identifying the separate transmit and receive compartments in each cavity of the Fuji system:

[redacted]

81. The annotated photograph below indicates the transmit lenses outlined in red and the receive lenses in blue. When assembled together, the two cavities are slightly offset from each other, and the medium-range cavity on the left is tilted downward by 12 degrees:

[redacted]

ii. The Fuji does not have "an interior space that includes . . . a transmit path, and a receive path"

82. As shown in the diagram and photographs above, the Fuji does not use a single interior space that contains both a transmit path and a receive path. Instead, the transmit and receive paths are in separate compartments.

83. In Paragraph 76 of his Declaration, Mr. Kintz opines that the Fuji's transmit and receive paths are "necessarily" in the same "interior housing space." Nowhere in his Declaration does Mr. Kintz identify any evidence showing that the transmit and receive paths are in the same "interior space." Mr. Kintz's speculation about the design of Fuji is wrong, as Fuji does not meet the "an interior space that includes . . . a transmit path, and a receive path" limitation.

iii. The Fuji does not have a "reflective surface"

84. As shown in the diagram and photographs above, the Fuji does not use a "reflective surface" through which the receive path extends from the lens to the detectors. Instead, the light received from the lens is focused directly on the receive board—the light is not bounced off a reflective surface.

85. In Paragraph 72 of his Declaration, Mr. Kintz opines that the Fuji contains a wall that comprises a reflective surface, because it is "a common-lens system." Mr. Kintz's Declaration does not identify any evidence showing that this reflective surface exists in the Fuji. Mr. Kintz was again wrong in his speculation about the design of Fuji, which does not meet the "reflective surface" limitation.

iv. The Fuji does not have a single lens that is configured to both "collimate the light beams for transmission" and "focus the collected light onto the detectors via the receive path"

86. As shown in the diagram and photographs above, the Fuji does not use a single lens for collimating the light beams for transmission, and for receiving and focusing the collected light. Instead, each cavity in the Fuji has separate transmit and receive lenses. The light from the transmit block is collimated when it passes through the transmit lens. The light that reflected off the surroundings is collected and focused by the receive lens, through which the light travels along the receive path to the receive board.

87. In Paragraphs 65-77, 86-87 of his Declaration, Mr. Kintz opines that the Fuji uses a "single common lens design." Mr. Kintz relies on his analysis of the Fuji PCB, alleging that the placement of the diodes point to a single lens design. This analysis is wrong. The actual Fuji system does not meet the single "lens is configured to . . . collimate the light beams for transmission . . . focus the collected light onto the detectors via the receive path" limitation.

IX. THE '464 PATENT

A. Overview of the '464 Patent

88. The '464 patent is a continuation of the application that resulted in the issuance of the '922 patent. As with the '922 patent, the Examiner initially rejected the claims as obvious over a combination of U.S. Patent No. 7,969,558 (Hall), U.S. Patent No. 6,046,800 (Ohtomo), and U.S. Application No. 2002/014924 (Wangler). The applicant overcame the rejection by amending the independent claims to recite "wherein the transmit path at least partially overlaps the receive path in the interior space between the transmit block and the receive block."

89. The '464 patent shares the same specification as the '922 patent. Figure 2, which illustrates the embodiment of the '464 patent, is identical to Figure 2 of the '922 patent.

90. The explanation provided in Paragraph 79-81 above of the features in Figure 2 of the '922 patent also applies to the '464 patent.

91. All claims of the '464 patent require a single "interior space" containing both the transmit and receive paths, "a transmit path [that] at least partially overlaps the receive path in the interior space," and a single lens for transmitting and receiving light. For example, Claim 1 recites (emphasis added):

> 1. A light detection and ranging (LIDAR) device, comprising:
>
> a lens mounted to a housing, wherein the housing is configured to rotate about an axis and has an **interior space that includes a transmit block, a receive block, a transmit path, and a receive path**, wherein the transmit block has an exit aperture, wherein the receive block has an entrance aperture, wherein the transmit path extends from the exit aperture to the lens, wherein the receive path extends from the lens to the entrance aperture, and wherein **the transmit path at least partially overlaps the receive path in the interior space** between the transmit block and the receive block;
>
> a plurality of light sources in the transmit block, wherein the plurality of light sources are configured to emit a plurality of light beams through the exit aperture in a plurality of different directions, the light beams comprising light having wavelengths in a wavelength range;
>
> a plurality of detectors in the receive block, wherein the plurality of detectors are configured to detect light having wavelengths in the wavelength range; and
>
> wherein **the lens is configured** to receive the light beams via the transmit path, **collimate the light beams for transmission** into an environment of the LIDAR device, collect light comprising light from one or more of the collimated light beams reflected by one or more objects in the environment of the LIDAR device, and **focus the collected light onto the detectors via the receive path**.

B. Person of Ordinary Skill in the Art

92. My opinion regarding a person of ordinary skill in the art with respect to the '922 patent, stated above, also applies to the '464 patent.

C. Non-infringement of Claims 1 and 14

93. Uber's Fuji design does not infringe Claim 1 of the '464 patent because it does not contain (1) "an interior space that includes . . . a transmit path, and a receive path"; (2) a transmit path that "at least partially overlaps the receive path in the interior space," or (3) a single lens

configured to both "collimate the light beams for transmission" and "focus the collected light onto the detectors via the receive path."

94. Claim 14 of the '464 patent depends from Claim 1, and Uber's Fuji design does not infringe Claim 14 because it does not infringe Claim 1.

i. The Fuji does not have "an interior space that includes . . . a transmit path, and a receive path"

95. As shown in the diagram and photographs in this Declaration, the Fuji does not use a single interior space that contains both a transmit path and a receive path. Instead, the transmit path and receive path are in separate compartments.

96. In Paragraph 114 of his Declaration, Mr. Kintz opines that the Fuji's transmit and receive paths are "necessarily" in the same "interior housing space." Nowhere in his Declaration does Mr. Kintz identify any evidence showing that the transmit path and the receive path are in the same "interior space." Mr. Kintz's speculation about the design of Fuji was wrong, as the Fuji does not meet the "an interior space that includes . . . a transmit path, and a receive path" limitation.

ii. The Fuji does not have a transmit path that "at least partially overlaps the receive path in the interior space"

97. As shown in the diagram and photographs in this Declaration, the Fuji does not have a transmit path that "at least partially overlaps the receive path in the interior space," because, for each individual cavity, the transmit path and receive path are in separate compartments, separated by solid walls. In one compartment, the transmit path extends from the diodes on the transmit block to the transmit lens. In a different compartment, the receive path extends from the receive lens to the detectors on the receive board. The transmit path and receive path never overlap (i.e. never intersect).

98. In Paragraph 118 of his Declaration, Mr. Kintz opines that, in a common lens system, the transmit path and receive path "share a path, that is to say, overlap." He also opines that, in the Fuji, "any receive-path beam that bounces off the mirror on the opposite side of the exit aperture from the receive block will necessarily overlap its own transmit path on the way to

the receive block." Nowhere in his Declaration does Mr. Kintz identify evidence showing that this overlap exists in the Fuji. Mr. Kintz was wrong about the design of Fuji, which does not meet the "a transmit path [that] at least partially overlaps the receive path in the interior space" limitation.

iii. The Fuji does not have a single lens that is configured to both "collimate the light beams for transmission" and "focus the collected light onto the detectors via the receive path"

99. In Paragraphs 75-78 of his Declaration, Mr. Kintz opines that the Fuji uses a "single common lens design." Mr. Kintz relies on his analysis of the Fuji PCB, alleging that the placement of the diodes point to a single lens design. This analysis is wrong. The actual Fuji system does not meet the single "lens is configured to . . . collimate the light beams for transmission . . . focus the collected light onto the detectors via the receive path" limitation.

100. As shown in the diagram and photographs above, the Fuji does not use a single lens for collimating the light beams for transmission, and for receiving and focusing the collected light. Instead, each cavity in the Fuji has separate transmit and receive lenses. The light from the transmit block is collimated when it passes through the transmit lens. The light that reflected off the surroundings is collected and focused by the receive lens, through which the light travels along the receive path to the receive board.

X. CONCLUSION

101. Based on my analysis of the alleged trade secrets identified in Paragraphs 29-35 of the Kintz Declaration and my analysis of the '922 and '464 patents, I conclude that: (1) the [redacted] in Paragraphs 29-35 of the Kintz Declaration is not a trade secret; (2) Uber's Fuji was independently developed and the Fuji did not incorporate, or rely upon, Waymo's [redacted] and (3) Uber's Fuji system does not infringe the '922 and '464 patents.

I declare until penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed this 7th day of April, 2017, in Columbus, Indiana.

Paul McManamon

Paul McManamon